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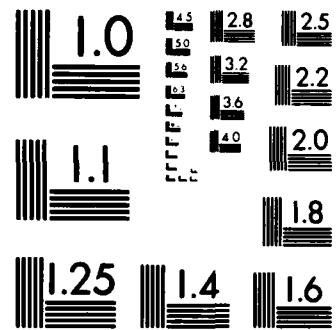
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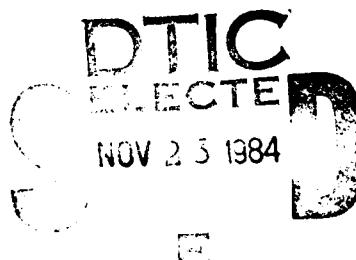
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MEMORANDUM REPORT BRL-MR-3393

A SHOCK TUBE POWDER DISPERSAL UNIT

Leon J. Decker
Arthur Cohen
Emmett Donnelly

October 1984



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US ARMY BALLISTIC RESEARCH LABORATORY
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) <i>1MM</i> A simple device for producing a dusty gas at the end wall of a shock tube prior to the arrival of the test shock wave has been produced and tested. It is readily adapted to existing equipment with minimal modifications.		

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I. INTRODUCTION

It is advantageous to use reflected shock waves to study the chemical reactions of powdered materials at high temperatures and pressures in shock tubes. Difficulties in interpretation of experimental results are considerably reduced when the powders are uniformly distributed as a dusty gas adjacent to the end wall of the tube. This unit provides a means of forming such a gas at time which can be varied prior to arrival of the shock wave. Dusty gases have been produced in shock tubes by using the incident shock flow to disperse powders from aerodynamic foils (knife-edge, contoured disk, etc.) or thin films. These techniques are capable of generating a dusty gas in the test section of the tube, but the powder cannot be uniformly distributed near the end wall, and the formation times are controlled solely by the arrival of the incident shock wave. Tests thus made can only approximate desired conditions.

Woodburn, Everson, and Kirk¹ used a vertical shock tube with a blower and solenoid valve assembly at the end wall to produce a dusty gas *in situ* prior to shock initiation. The solenoid valves were located in the end and side walls respectively and were closed immediately before shock initiation.

The powder dispersal unit described herein generates a gaseous suspension of solid particles in the volume adjacent to the end wall of the shock tube, creating the desired dusty gas experimental condition prior to the arrival of the test shock wave. This device provides the test conditions that the various shelf/knife edge/diaphragm techniques only approximate. It can be readily incorporated into existing shock tubes through a simple end-plate modification. Modifying a shock tube by placing it in a vertical plane and adding solenoid valves requiring end-plate and side wall modifications is considerably more costly and, in our facility, physically impossible.

II. EXPERIMENTAL/RESULTS

A schematic of the dispersal unit is shown in Figure 1. Photographs of the unit are shown in Figures 2, 3 and 4. The initial shock wave is used to generate a time-delayed gated pulse which is conducted through a brass contact (7) into an electrical primer (6) detonating the primer 1 to 5 ms prior to the arrival of the incident shock wave at the end wall of the shock tube. This timing ensures that the dust will be thoroughly and uniformly dispersed into the test gas at the time of shock reflection. The detonation of primer (6) drives lexan piston (5) down the smooth bored cylinder (17) contained within the main body (14) of the device. As the leading edge of piston (5) passes vent port (12), the gases in cylinder (17) between diaphragm (1) and piston (5) are trapped and compressed. The compressed gas ruptures the first diaphragm (1), blows through the sample chamber (3), and then ruptures the second diaphragm (2). The powdered sample stored in chamber (3) is carried by the compressed gas into the shock tube where it is turbulently mixed into the test gas. Photographs obtained using a high speed framing camera showed that

¹E.T. Woodburn, R.C. Everson and A.R.M. Kirk, "Thermal Decomposition and Hydrogenation of Coal Dust in a Shock Tube," Fuel, Vol. 53, p. 38, 1974.

the powder (<37 μm) was dispersed and uniformly distributed in less than two-thirds ms after initiation of firing pulse. The distribution remained fairly uniform for approximately seven ms. Diaphragms (1) and (2) are selected from materials appropriate for the pressures involved, i.e., aluminum foil, mylar sheet, etc. The diaphragms may be held in place by adhesives at low shock tube pressures, or by "O" rings at higher pressures.

III. CONCLUSION

This device was used to examine dusty gases composed of stoichiometric H_2/O_2 mixtures containing K_2SO_4 and KNO_3 respectively. The information thus obtained has been reported elsewhere.² This invention provided a reliable, operationally simple means of producing dusty gases at the end wall of a shock tube prior to arrival of the incident shock wave.

Details of Sketch:

- (1) First diaphragm
- (2) Second diaphragm (flush with end wall)
- (3) Sample chamber
- (4) First edge of sample chamber
- (5) Lexan piston deformable, 0.3775 inches OD in our application
- (6) Electric primer M52A3B1
- (7) Brass contact to conduct firing pulse into primer
- (8) Brass plate machined to receive primer and to complete circuit for the firing pulse
- (9a,9b) Phenolic backing plates to support and insulate brass contact (7)
- (10) Steel supporting plate
- (11) Steel assembly screws
- (12) Vent port (6 mm diameter)
- (13) Threaded plug containing sample chamber (3) with flat surfaces for supporting diaphragms (1,2)
- (14) Main body of mechanism machined from iron or brass stock

²A. Cohen and L. Decker, "Chemical Mechanism for Secondary Flash Suppression," Eighteenth Symposium (International) on Combustion, p. 225, 1981.

- (15) Portion of main body (14) threaded to mate with plug (13)
- (16) Portion of main body (14) threaded to mate with end wall of shock tube (not shown)
- (17) Smooth bored cylinder 0.3780 inches ID in main body (14) through which piston (5) is driven

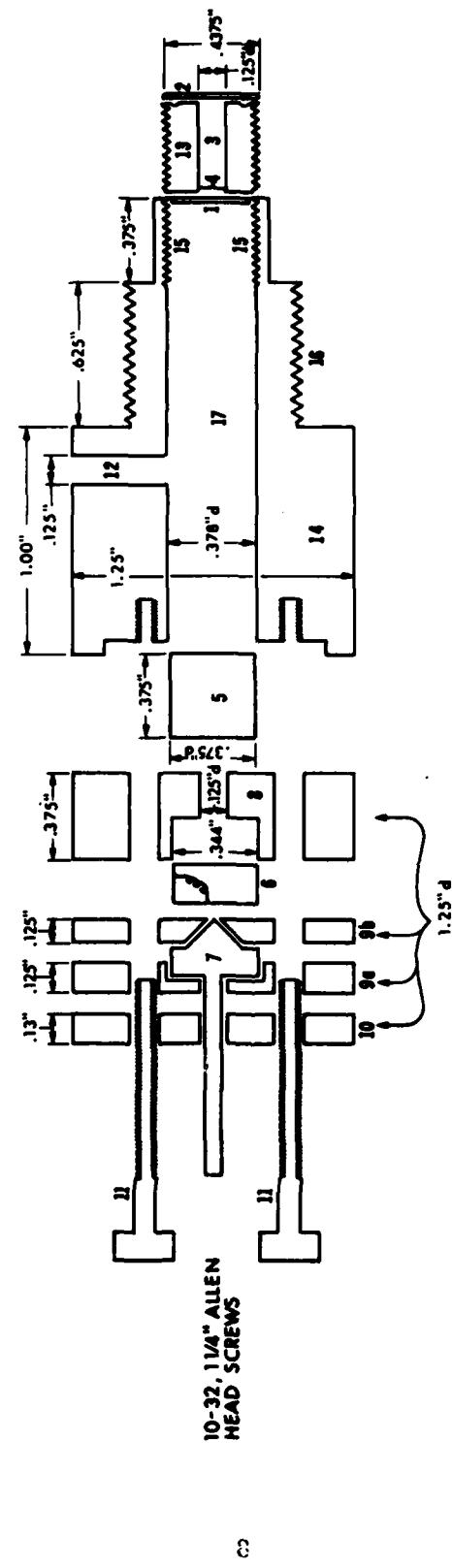


Figure 1. Schematic Diagram of Powder Dispersal Unit

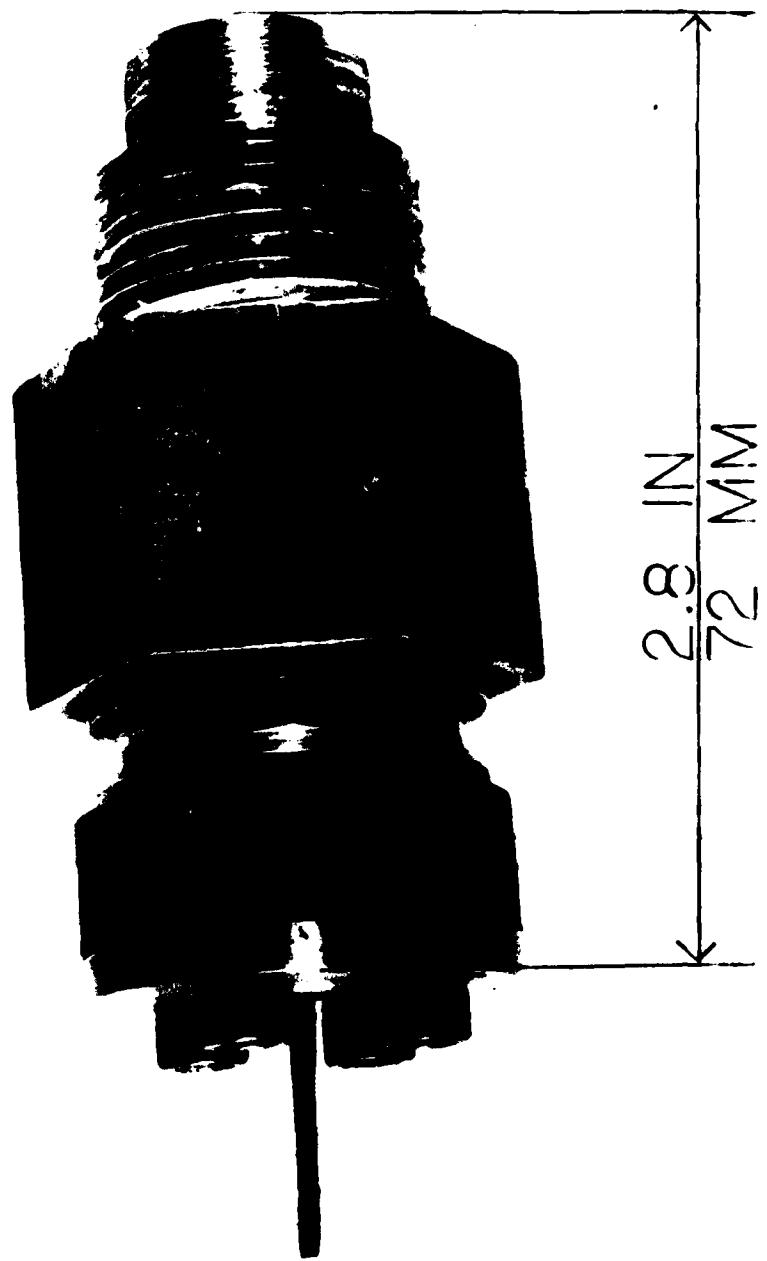


Figure 2. Photograph of Assembled Powder Dispersal Unit

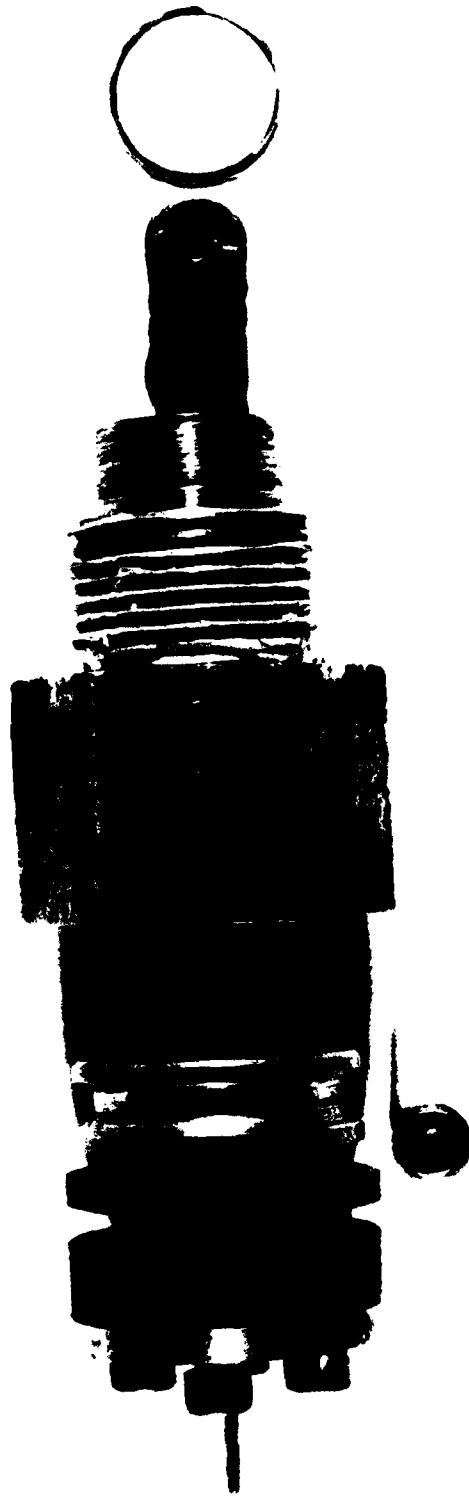


Figure 3. Photograph of Partially Disassembled Powder Dispersal Unit

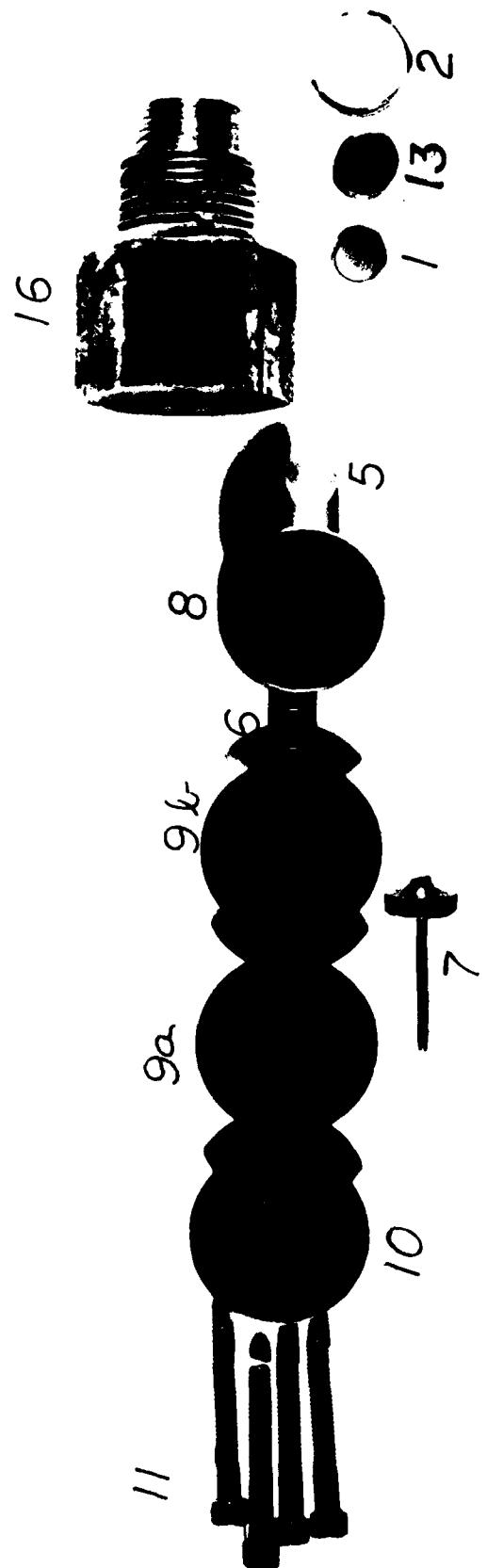


Figure 4. Photograph of Completely Disassembled Powder Dispersal Unit

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